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PATENT SPECIFICATION 654,046

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COMPLETE SPECIFICATION.

Improvements in or relating to Self Adjusting Valve Tappets for Internal Combustion Engines.

We, THE WEATHERHEAD COMPANY, a corporation organised under the laws of the State of Ohio, United States of America, of 300, East 131st Street, Cleveland, Ohio, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement :—

The invention relates to valve tappets and concerns particularly self-adjusting hydraulic tappets for internal combustion engines.

In such hydraulic tappets, it is important that the relatively movable surfaces are adequately sealed in such a manner that no leakage normally occurs from the system when the engine of which the valve forms a part is in operation.

Hydraulic systems of the nature to which reference is here made mostly contain a piston telescoping in a cylinder in order to adjust the length of the tappet. Hydraulic fluid is contained in the cylinder and in part of the piston and a pressure chamber is formed in the cylinder and a fluid reservoir in the piston. It is particularly important that some provision should be made for some leakage or fluid transfer from the pressure chamber to the reservoir so that expansion of the liquid due to temperature changes will not lengthen the tappet after all the clearance is taken up but will merely produce fluid transfer from the pressure chamber to the reservoir (in a reverse direction to the transfer effected when the tappet is being lengthened).

According to the invention there is provided a self-adjusting hydraulic tappet for internal combustion engines including a cylinder member, a piston member telescoped with said cylinder member and co-operating therewith to form a hydraulic pressure chamber, a hydraulic reservoir chamber formed in the piston member, said pressure chamber and reservoir chamber having a common wall portion integral with said piston member, fluid transfer port means including a port formed in said common wall portion for fluid transfer between said chambers, hydraulic fluid filling said pressure chamber and partially filling said reservoir chamber, fluid sealing means between said cylinder and piston members for preventing leakage of fluid from said pressure chamber past said piston member, and resilient means in said reservoir chamber for causing transfer of fluid through said transfer port means from the reservoir chamber to the pressure chamber to thereby allow relative movement of said members in order to increase the tappet length, wherein the wall portions of said piston and cylinder members that define said hydraulic chamber are imperforate except for said fluid transfer port means between said pressure and reservoir chambers, said fluid sealing means insuring that all fluid transfer between said chambers occurs through said transfer port means, said transfer port means including in addition to said port a relatively minute passageway which is open at all times and effective while the tappet is being lengthened to allow the length of said tappet to increase gradually.

In order that the invention may be fully understood it will now be described with reference to the accompanying drawings, in which:

Fig. 1 is a longitudinal sectional view of a poppet valve and stem with a self-adjusting tappet therefor forming an embodiment of the invention;

Fig. 2 is a similar section as Fig. 1 through another embodiment of the invention;

Fig. 3 is a fragmentary view showing in greater detail a portion of the apparatus in Fig. 2.

Fig. 4 is a longitudinal sectional view of an extensible self-compensating tappet employing a cylindrical poppet type of check valve.

Fig. 5 is a cross-sectional view of the

apparatus of Fig. 3 represented as cut by a plane 5—5.

Referring to Fig. 1 the arrangement shown therein by way of illustration comprises a portion of a casing 111 for an internal combustion engine such as a petrol engine for example, having a conventional poppet valve 112 controlled by a valve stem or rod 113 slidable in a suitable guide or bushing 114. A valve spring 115 is provided for normally closing the valve 112 by moving the stem 113 in the downward direction. A tappet 116 is provided for transferring the action of a valve operating cam 117 to the valve rod 113. As in conventional constructions the tappet 116 has a hardened portion 118 adapted to ride on the cam 117 and a hardened surface 119 adapted to contact the lower end 121 of the rod 113.

The tappet 116 comprises two parts 122 and 123 which are relatively movable longitudinally, although, as will be explained hereinafter, the extent of movement required is relatively limited. One of these parts, for example, the part 122, takes the form of a hydraulic cylinder and the other which is the part 123 takes the form of a piston. A suitable relatively incompressible hydraulic fluid 124 such as oil, for example, is provided for filling the cylinder 122, and a reservoir 125 is formed in the piston 123 for supplying oil to the cylinder 122 to extend the tappet length.

The piston 123 and the cylinder 122 are each closed at the outer end and the piston 123 is provided with an inner transverse wall 126.

There are means permitting restricted passage of the hydraulic fluid or oil between the reservoir 125 and the cylinder 122. A minute passage 127 is formed in the transverse wall 126 for permitting metered or accurately controlled transfer of oil to the reservoir 125 from the cylinder 122. For quick return of oil from the piston to the cylinder, a suitable check valve 128 is provided which is shown for the sake of illustration as being of the spring-pressed ball type and prevents back flow of the oil into reservoir 125.

The piston 123 is arranged to be slidable within the cylinder 122 at the open or upper end thereof. In the specific arrangement illustrated, the piston 123 is provided with an expanded or flaring lower end 129 serving as a guide slidably fitting within the cylinder 122.

In the arrangement of Fig. 1 suitable means are provided for resiliently expelling or tending to expel hydraulic fluid from the reservoir 125 into the cylinder 122. Such means may take the form of a closed air or gas filled ball or inflated bulb 131 composed of rubber or synthetic plastic or other suitable flexible impervious material.

A seal is provided between the cylinder 122 and the piston 123 and the arrangement is such that no hydraulic fluid can leak back from the cylinder 122 to the reservoir 125 without passing through the metering orifice 127. In this manner exact control of the fluid passage is obtained. In the specific arrangement illustrated in Fig. 1 the parts 122 and 123 are sealed to each other by means of a gasket or ring of flexible material, such as rubber or the like 132. The piston 123 is formed with a reduced-diameter upper portion or neck 133 to provide space for the sealing ring 132 between the neck 133 and the inner surface of the upper end of the cylinder 122. Preferably surfaces of the sealing ring 132 are cemented to the surfaces of the piston neck 133 and the cylinder 122 and then bonded by vulcanization.

If the engine starts up cold some play exists between the cam 117 and the valve rod 113 as long as the parts are not extended due to heat. The pressure bulb 131 expels oil from the reservoir 125 through the check valve 128 into the cylinder 122 in order to extend the tappet and take up the looseness. The design is such that the pressure on the fluid produced by the bulb 131 is insufficient to counteract the strength of the spring 115, so that no compression of the spring 115 is produced by the tendency of the hydraulic fluid or oil to pass from the reservoir 125 to the cylinder 122.

When the cam 117 rises the body of oil 124 is subjected to pressure by the force of the cam aginst the surface 118 and the tappet 122 is driven upward against the lower end 121 of the valve rod 113 so as to open the poppet valve 112. A minute amount of oil is pushed under pressure from the cylinder 122 back through the orifice 127 into the reservoir 125. However, the orifice is of sufficiently small diameter so that the small leakage of oil taking place will not prevent requisite opening of the poppet valve 112. The oil returned to the reservoir 125, however, tends to produce momentarily a slight shortening of the tappet and consequently would tend to introduce a slight clearance. Nevertheless, owing to the fact that the dwell of the cam 117 is longer in the downward position of the follower 118 than during the 90 degrees of cam rotation during which the follower 118 is caused to rise, oil is permitted to travel back through the orifice 127 and the check valve 128 to re-extend the tappet before the next upward stroke. Consequently, no clearance occurs between the tappet end 119 and the lower end of the push rod 121, during the power stroke of the cam 117. Thus the tappet constantly hunts for its correct length without ever being out of limits of clearance.

It will be observed that the orifice 127

is somewhat off centre so that there is a tendency for the oil in passing back and forth between the reservoir 125 and the cylinder 122 to introduce turbulence in the body of oil 124, thereby tending to cause some flow of oil along the surfaces of the cylinder 122 to cool the cylinder.

Since the oil 124 cannot return to the reservoir 125 on the upward stroke of the stem 117 except through the orifice 127, the return flow of oil is precisely metered and constancy and regularity of operation of the poppet valve 112 in response to the operation of the cam 117 is obtained.

The arrangement in the embodiment shown is such that the hydraulic fluid 124 cannot leak from the pressure chamber around the lower edges of the open end of the piston 123 farther than until it reaches the gasket or ring 132 so that, once the space under said gasket is filled, the only flow of hydraulic fluid from the cylinder 122 takes place through the orifice 127 to the reservoir 125. This is accomplished in the arrangement of Fig. 1. However, the invention is not limited to the specific arrangement illustrated in Fig. 1.

Referring now to Fig. 2 the arrangement shown therein by way of illustration comprises a portion of a casing 11 for an internal combustion engine, such as a petrol engine for example, having a conventional poppet valve 12 controlled by valve stem or rod 13 slidable in a suitable guide or bushing 14. A valve spring 15 is provided for normally closing the valve 12 by moving the stem 13 in the downward direction. A tappet 16 is provided for transferring the action of a valve-operating cam 17 to the valve rod 13. As in conventional constructions, the tappet 16 has a hardened portion 18 adapted to ride on the cam 17 and a hardened surface 19 adapted to contact the lower end 21 of the rod 13.

The tappet 16 comprises two parts 22 and 23 which are relatively movable longitudinally, although, the extent of movement actually required is relatively limited. One of these parts, for example, the part 22, takes the form of a hydraulic cylinder, and the other, which is the part 23, takes the form of a hollow piston. A suitable, relatively incompressible, hydraulic fluid such as oil, for example, is provided for filling the cylinder 22 and a reservoir 25 is formed in the piston 23 for supplying oil to the cylinder 22 to extend the tappet length.

The cylinder 22 is closed at the lower or outer end and the piston 23 is provided with an inner transverse wall 26. For closing the piston 23 above the inner transverse wall 26, suitable means such as a plunger 27 may be provided.

There are means permitting restricted passage of the hydraulic fluid or oil between the reservoir 25 and the cylinder 22. For quick return of oil to the cylinder a suitable check-valve 28 is preferably provided in the transverse wall 26 which prevents back flow of liquid into the reservoir 25. In the arrangement of Fig. 2 the check-valve 28 is shown as being of the free-floating ball type.

To facilitate manufacturing and assembling operations, a screw-cap 29, the top of which forms the hardened top face 19, may be provided at the upper end of the hollow piston 23 to form the top of the tappet 16. Suitable means are provided for sealing the plunger 27 in the piston 23 such as a ring 31 composed of resilient material such as rubber or synthetic composition, fitted in an annular groove 32 around the plunger 27 of greater cross section than the sealing ring 31. In non-flexed or uncompressed condition the resilient ring 31 has a diameter greater than the depth of the groove 32.

A similar seal is formed between the piston 23 and the cylinder 22 which may take the form of a ring 34 in an annular groove 35 around the portion of the piston 22 at which the transverse wall 26 is located.

Suitable means are provided for resiliently expelling or tending to expel hydraulic fluid from the reservoir 25 into the cylinder 22. This may be accomplished by means of the plunger 27. For forcing the plunger 27 downward upon the top surface of the body of oil in the reservoir 25, suitable means are provided such as a compression spring 33 between the screw-cap 29 and the plunger 27. The spring 33 is weaker than the valve spring 15.

The check-valve 28 is of the ball and seat type and comprises a ball 36 with an upper seat 37 and a lower seat 38. The upper seat 37 takes the form of a shoulder in the opening 30 through the transverse piston wall 26. Preferably, the opening 30 is narrowed at the upper end to form a small orifice 39. The lower ball seat 38 is produced by threading a bushing 41 into the opening 30, the lower portion of which is internally threaded to receive the bushing 41. The upper edge of the bushing 41 forms the lower ball seat 38.

In order that the oil or hydraulic fluid may pass readily in either direction, when the ball 36 is resting upon the lower seat 38 as well as when it is slightly raised, a passage is formed in the edge of the bushing 41 preferably in the form of a groove 42.

The surface of the cam 17 may be divided into three distinctive portions, namely the portion between the points 43 and 44 during which the cam is rising and lifting the cam follower 18, the portion between the points 44 and 45 during which the cam surface is falling and allowing the cam follower 18 to fall, and the portion between the points 43 and 45 representing the base circle upon which

the cam follower surface 18 rests or dwells without motion in either direction. During the time that the portion of the cam surface between the points 43 and 44 is contacting the cam follower 18 forcing the cylinder 22 upward against the pressure of the spring 15, pressure is applied to the body of fluid 24 causing the fluid to rise through the opening 30 and to lift the ball 36 against the upper seat 37, thus closing the check-valve 28.

A certain amount of fluid, however, is permitted to escape through the orifice 39 into the reservoir 25 during the time required for the ball 36 to rise against the seat 37. This slight amount of fluid has an imperceptible effect upon the length of the tappet, but with successive strokes permits the tappet length to adjust itself, when required, to permit the valve 12 to close fully when the cam follower 18 is resting upon the base circle of the cam 17. This condition may arise, for example, in case the engine is restarted after it has cooled off and the changes in temperature have affected the valve clearances.

However, as the engine warms up increasing the clearances between the cam 17 and the push-rod 13, most efficient operation of the engine requires the reduction of the clearance to zero by the extension of the tappet 16. This is accomplished by the pressure of the plunger 27 downward upon the upper surface of the fluid in the reservoir 25. When the cam 17 is no longer on the pressure stroke, the pressure on the hydraulic fluid is relieved enabling the spring 33 to press the plunger 27 downward and expel oil from the reservoir 25 through the orifice 39 and the opening 30. In the event that this pressure should be insufficient to break the seal between the ball 36 and the upper seat 37, the inertia of the ball will break the seal when the tappet is abruptly brought to rest at the end of the down stroke of the cam, when the cam follower 18 comes to rest upon the base circle between the points 43 and 45 of the cam 17. Fluid then passes from the reservoir 25 through the orifice 39 around the ball 36 and through the remainder of the opening 30 into the cylinder 24, extending the tappet in length until all clearance is closed between the upper end 19 of the tappet and the lower end 21 of the push rod, the valve 12 then being seated. Since the spring 33 is weaker than the valve spring 15, there is no tendency for the action of the plunger 27 to lift the valve 12 from its seat. However, the ball 36 may drop to its seat 38 and rest directly upon it while the oil is flowing from the reservoir 25. No interference is caused with the transfer of oil to the cylinder 22 owing to the passage permitted by the groove 42. The force of the spring 33 is, however, sufficient to overcome friction of the rings 31 and 34.

A greater degree of inertia effect for opening the check-valve 28 may be obtained by utilizing a heavier valve closing member such as a poppet 46, for example, as illustrated in Fig. 4. The poppet 46 preferably has a cylindrical main outer surface with frusto-conical ends 47 and 48 adapted to engage upper and lower valve seats 37^1 and 38^1 respectively. It will be understood that a cylindrical recess 49 is provided of sufficient length in the opening 30 for receiving the poppet 46. The use of substantially frusto-conical seat engaging surfaces 47 and 48 has a certain advantage over the use of spherical surfaces, as in the case of a ball check valve, in that it reduces the cost of machining and finishing operations on the seats 37^1 and 38^1. In the arrangement of Fig. 4, a groove such as the groove 42 of Figs. 2 and 3 is employed for the same purpose as in the arrangement of Figs. 2 and 3.

To avoid upward travel of plunger 27 above a safe limit a recess or drain hole 51 is preferably provided. The drain hole 51 is drilled into the side of the hollow piston 23 at the point determining the desired upper limit of the body of oil to be contained in the cylinder 22 and the reservoir 25. If any excess oil should be placed in the reservoir 25 during assembly, this excess leaks out through the hole 51, whereupon the plunger 27 moves downward in the piston 23 below the drain hole 51 so as to prevent the leakage of any further fluid.

Assembly of the apparatus is preferably carried out in the following manner. With the piston 23 separated from the cylinder 22 and inverted, and with the cap 29 removed, the ball 36 or the poppet 46 is dropped in place in the opening 30 whereupon the bushing 41 is threaded into position retaining the ball 36 or the poppet 46. The cylinder 22 is then placed with the closed end downward and partly filled with oil whereupon the piston 23 is inserted in the cylinder 22 and the oil is allowed to rise through the opening 30, until all of the air is expelled from under the check valve, and the check valve is seated by oil pressure. The piston is pressed downward slowly enough so that the entrapped air escapes through the groove 42 and does not lift the ball 36, or the poppet where this is used, whereupon additional oil is poured into the piston 23, the upper end of which is still open. After a quantity of oil has been poured therein to insure covering the portion of the opening 30 around the upper seat 37 and provide a body of oil above the transverse wall 26 substantially up to the drainage hole 51, the plunger 27 is inserted. The spring 33 is then inserted and compressed sufficiently to enable the cap 29 to be inserted into the upper end of the piston 23 to be threaded in place, thus leaving the spring 33

into compressed condition and urging the plunger 27 downward against the oil surface in the reservoir 25. Any excess oil or entrapped air under the plunger 27 is expelled through the drain hole 51.

In connection with Figs. 2 and 3 there is shown an O-ring arrangement including an O-ring 34 composed of compressible material for sealing the piston 23 in the cylinder 22. However, the invention is not limited to the specific arrangement illustrated in Figs 2 and 3 as other sealing means may be employed. For example, as illustrated in Fig. 4, the lower end of the piston 23 may be so formed and a bushing 41[1] of such dimensions may be employed that the bushing 41[1] extends below the lower end of the piston 23 and a gasket of suitable resilient material such as rubber or synthetic composition 52 may be cemented around the outer surface of the bushing 41[1] at the lower end thereof. The surfaces of the gasket 52 are pressed against the lower edge of the piston 23 and against the internal surface of the cylinder 22 when the bushing 41[1] is threaded into position.

As in the arrangement of Figs. 2 and 3, the arrangement of Fig. 4 serves to compensate automatically for conditions such as the changes in temperature which would tend to change valve clearances, and the tappet thus continually hunts for the proper length which reduces the clearance to zero.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is :—

1. A self-adjusting hydraulic tappet for internal combustion engines including a cylinder member, a piston member telescoped with said cylinder member and co-operating therewith to form a hydraulic pressure chamber, a hydraulic reservoir chamber formed in the piston member, said pressure chamber and reservoir chamber having a common wall portion integral with said piston member, fluid transfer port means including a port formed in said common wall portion for fluid transfer between said chambers, hydraulic fluid filling said pressure chamber and partially filling said reservoir chamber, fluid sealing means between said cylinder and piston member for preventing leakage of fluid from said pressure chamber past said piston member, and resilient means in said reservoir chamber for causing transfer of fluid through said transfer port means from the reservoir chamber to the pressure chamber to thereby allow relative movement of said members in order to increase the tappet length, wherein the wall portions of said piston and cylinder members that define said hydraulic pressure chamber are imperforate except for said fluid transfer port means between said pressure and reservoir chambers, said fluid sealing means insuring that all fluid transfer between said chambers occurs through said transfer port means, said transfer port means including in addition to said port a relatively minute passageway which is open at all times and effective while the tappet is being lengthened to allow the length of said tappet to increase gradually.

2. A self-adjusting tappet as claimed in Claim 1, wherein said resilient means is an inflated flexible bulb filling the remainder of said reservoir chamber.

3. A self-adjusting tappet as claimed in Claim 1, wherein said resilient means comprises a second sealed piston arranged in said piston member between said common wall portion and a closed outer end of said piston member, spring means being provided between said second piston and said closed end for urging said second piston downward upon the body of fluid in the piston member.

4. A self-adjusting tappet as claimed in Claim 1. 2 or 3, wherein said piston member has a neck of smaller diameter than said cylinder member and said fluid sealing means is formed by flexible rubber-like material extending between said cylinder and said neck and bonded to each member.

5. A self-adjusting tappet as claimed in Claim 1, 2 or 3, wherein said fluid sealing means is formed by an O-ring disposed in a groove in a portion of one of said members which is in sliding contact with a portion of the other member.

6. A self-adjusting tappet as claimed in any of the preceding claims, wherein said port means or an additional port means is positioned to circulate fluid along the piston and cylinder member side walls for cooling, the port means being preferably eccentric with respect to the piston member.

7. A self-adjusting tappet as claimed in any of the preceding claims, wherein said transfer port means has a valve seat and a valve member is provided for engaging said valve seat.

8. A self-adjusting hydraulic tappet for internal combustion engines constructed and adapted to operate substantially as described and shown in the accompanying drawings.

Dated the 9th day of April, 1946.

For:

THE WEATHERHEAD COMPANY,

STEVENS, LANGNER, PARRY & ROLLINSON.

Chartered Patent Agents,

5–9 Quality Court, Chancery Lane, London, W.C.2.

and at

120, East 41st Street, New York, 17, New York, U.S.A.

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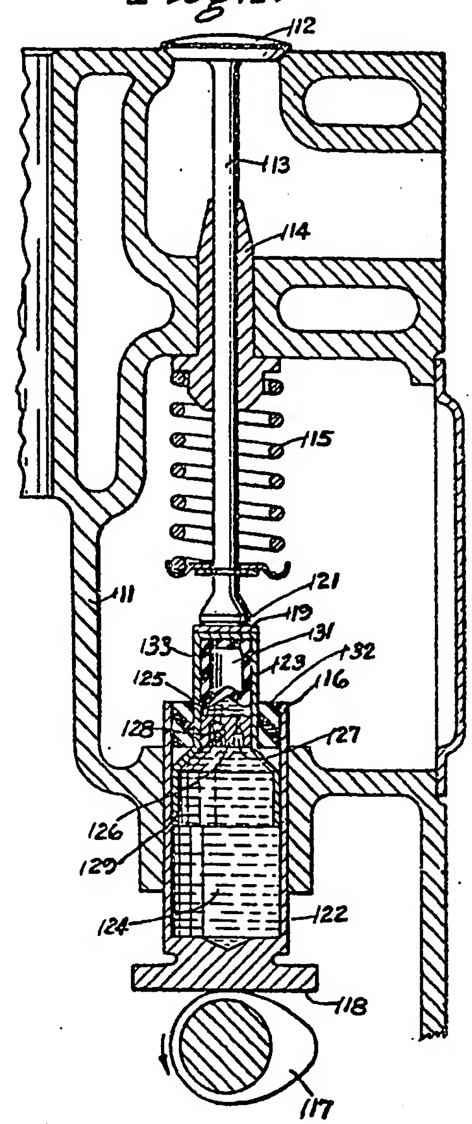
SHEET 1

Fig. 1.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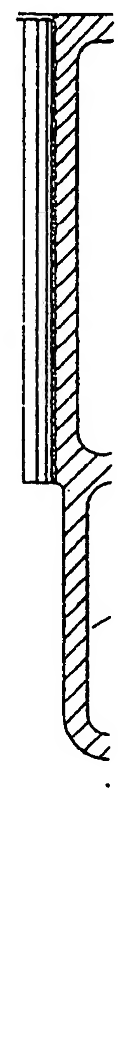


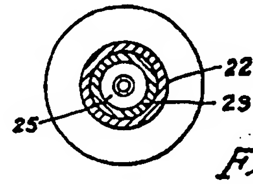


Fig. 5

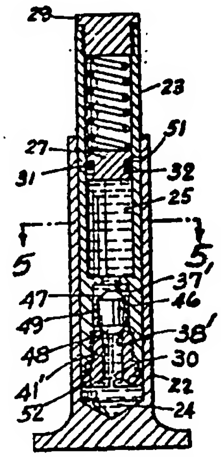


Fig. 4.

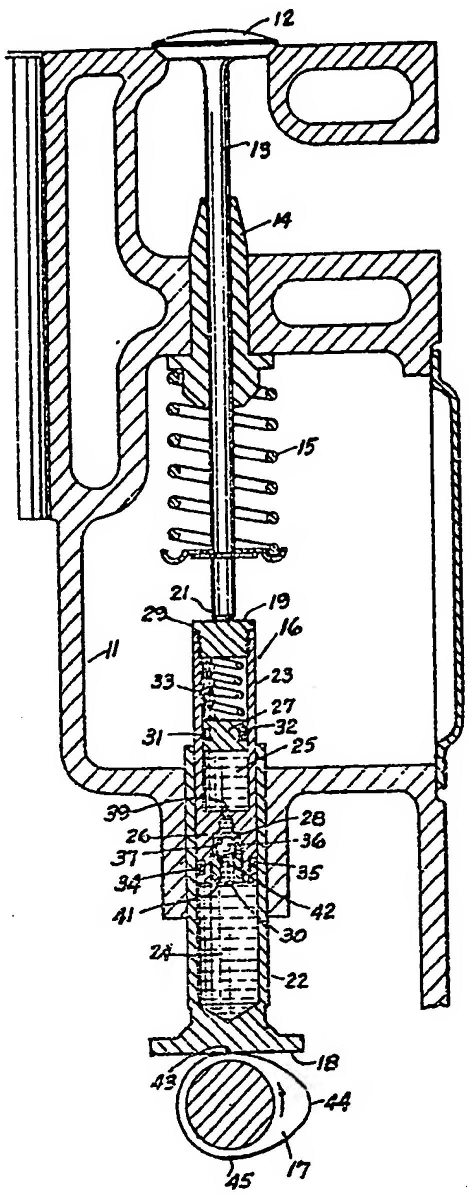


Fig. 2

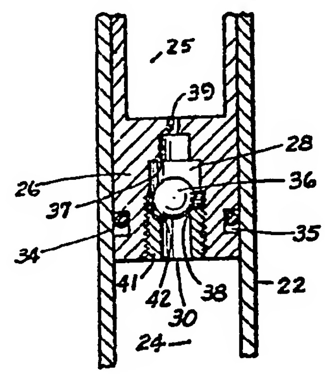


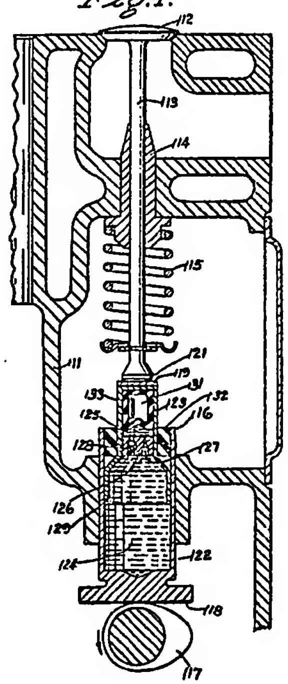
Fig. 3.

654,046 COMPLETE SPECIFICATION

2 SHEETS

SHEET 1

Fig.1.



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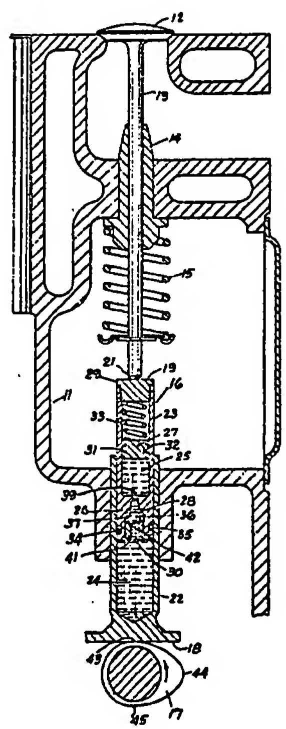

Fig. 2

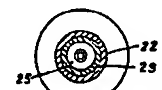

Fig. 5

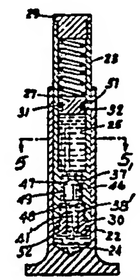

Fig. 4.

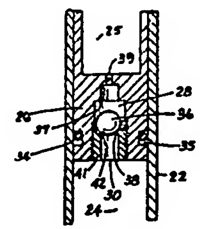

Fig. 3.

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H.M.S.O.(M.F.P.)